Cryptogr. Tracts
(Fungi).

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CIRCULARS AND AGRICULTURAL JOURNAL
OF THE ROYAL BOTANIC GARDENS, CEYLON.

VOL. II., NO. 28, JANUARY, 1905.

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BRANCH CANKER IN TEA.

BRANCH canker in tea is caused by a fungus belonging to the family *Nectria*, of which a large number cause cankers in living timber and fruit trees. The spores of the fungus are spread by the wind, and under suitable conditions these spores germinate and penetrate the living tissues of the bark of the tea bush, causing a discolouration and as a rule a wound on the branch of the tea bush where it grows.

The disease has been known in India for five years or more, and Watt and Mann in "Pests and Blights of the Tea Plant," 1903, page 408, give an account of its depredations in Assam and Cachar, describing it as attacking both new wood and the older branches of tea bushes. The fungus is referred by them to *Nectria ditissima*, but so far as my examination has gone it differs from *Nectria ditissima*, and is probably a new species. I have only been able to collect a very few specimens of the fruiting parts of the fungus, by which alone it is possible to correctly describe and name it, and I hope to describe it scientifically in another publication.

History in Ceylon.

The history of this disease in Ceylon is like the story of most fungus diseases on cultivated plants. Until the effects produced on the tea bushes were very marked and affected a

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large number of plants, the disease was either not observed or considered not worthy of any special attention, and was not brought to the notice of the Botanical Department.

Though this disease was undoubtedly present for some years in the Island, yet on my tours in the tea districts I did not notice it except on two occasions. In my field note-book for March, 1901, I find a note of having collected a specimen which I described as "canker," and again in June, 1902, the same year another similar case. That it was overlooked is due to the fact that it is only for a very short time after pruning—some ten or twelve days in growing weather—that this disease can be noticed. When the young buds are open it is impossible to notice its presence. The first intimation I received of the existence in any serious amount of this disease of tea was in June, 1903, when I received an inquiry and specimens from the Balangoda district. In this case the fungus was attacking the young shoots of the tea bushes, and could only be found on the "red wood" portions of the tea bush. It was affecting only a very small number of bushes, and after I had taken sufficient specimens for laboratory purposes I advised the Superintendent to prune back the bushes attacked and to burn all the prunings. This he did, and so far got rid of the evil that when more recently I wrote to him for further specimens he was only able after a careful search to obtain a specimen for me.

The attack of this fungus on the young shoots of the tea is rare in Ceylon, and I have only observed it in one other case in another district, and though I made a search of the neighbouring bushes found no other specimens.

In the beginning of the present year my attention was drawn to a disease prevalent in the older branches of tea bushes, and after making an examination of a large area of pruned tea I found that this disease existed to a considerable extent in various districts, and though there is more to be found in certain districts, my observation leads me to think that it will be found on tea all over the Island.

External Effects of the Disease.

The external appearance of this disease in tea branches varies but little, and in many thousands of cases I have seen the same characteristics are found. When the disease is found on the older branches it is almost invariably on the upper surface of horizontal branches; generally in fields affected by the disease the stoutest branches of fine old bushes are damaged. The wound runs parallel to the sides of the branch, and varies in length with the time in which the fungus has been growing in the branch, from 2 or 3 to 12 or 15 inches in length. It may be as wide as the branch, and it may extend even to the under side. The centre of the wound is—except in wet weather—dry, and the wood has been reduced to tinder and can be removed by the finger nail. If the edges of the wound be cut it will be found that in the majority of cases parts of the callus or cushion of healthy tissue are discoloured, showing that they are invaded by the mycelium of the fungus.

Where the callus is largest and the wound being most healed over, the discolouration will not be seen on cutting into the tissue, but where a not very vigorous effort has been made to cover over the open wound the edges will be found of a brownish or neutral tint. It is at these places that the fungus is most active and is invading and destroying the healthy callus as soon as it is formed.

The disease is generally to be found in the stage as above described, viz., open cracks or big wounds on the upper surface of horizontal branches, but when the fungus has got complete hold of a branch it sometimes spreads into the stem and other branches of the tea bush without causing any open wounds, and as it spreads it gradually kills the parts it invades until it eventually causes the death of the bush.

A specimen of the cankered tea bush was sent to me some nine months ago, and after diagnosing it, as half the plant was still alive and the roots had been very little injured

when it was dug out, I replanted it in an experimental plot near my laboratory. Two branches out of five were dead, having been "rung" by the canker, *i.e.*, the canker fungus had so thoroughly invaded the cambium at the base of the branch that no nutrition could pass up and the leaves had withered up. The other branches were still covered with green leaves which had flagged owing to the removal of the plant from the ground and its transport. These leaves, however, on carefully replanting the bush and watering it recovered and did not drop off. Each week I noted the appearance of the bush, and it was not for two months that any further progress of the canker could be noticed externally. Then another branch began to wither and died and within eight months the whole bush was dead.

An examination of the tissues of the bush showed that all round the main stem the tissues were full of fungus mycelium. Cases like the above are very rare, but it is of value to remember that in some cases not only is serious local injury caused by the canker fungus, but the death of the whole bush may ensue.

Distribution in Ceylon.

I have but rarely met with this disease in low-country tea, and as a rule it is found on the fine old well-grown bushes of the older tea districts. It finds, as I have mentioned before, a specially suitable place on the upper surface of large horizontal branches, and such branches are not found except on older bushes of good growth.

I have found the disease in nearly all tea districts I have visited at over 1,000 ft. elevation. In some estates it is doing considerable damage, and in others very few bushes are attacked. There is no reason to suppose that any district is entirely free from this evil. A careful examination should be made of all fields at pruning, and if the disease is found to exist measures should be at once taken for its eradication.

Rate of Growth of the Disease.

It is difficult to estimate the time since the disease first attacked Ceylon tea. I have had under continuous observation some bushes attacked by the fungus, and have measured the progress of the mycelium of the fungus in the tissues of the plant. Under favourable conditions, *i.e.*, continual dampness of the bark, I find the discoloured fungus area grows at the rate of about one inch in two months. This, however, must not be taken as anything but a very rough estimate of the progress of the fungus. Many factors must be taken into consideration in trying to estimate the rate of growth of a parasitic fungus in the tissues of its host—the physiological condition of the tea plant, the external conditions as to damp or drought, the number of spores causing the first attack of the fungus, &c.

It is however certain that dampness hastens the evil effects of the canker, that dry air and especially direct sunlight is a most effective deterrent, and that vigorous health in the tea bush which is attacked is no safeguard against the attack and spread of this parasite. The chief means of the spread of fungi is by means of wind carrying their spores to new places where they can grow. The spores can for practical purposes be considered as the seeds of the fungus. In the majority of fungi attacking the parts of plants above ground these spores are reproduced in vast quantities, so that if even one out of 100,000 eventually reaches a suitable place and germinates there will yet be a great spread of the disease. It is of the utmost importance, therefore, that the fruits or spore-producing bodies of such fungi should be collected and burnt, and for this reason all parts of a tea bush or other plant affected by fungi should always be cut off and burnt.

It is a point of hopefulness in regard to this canker in Ceylon that though I have carefully searched many thousands of bushes for the "perithecia" or fruits of this

fungus I have not been able to find them in the field. A specimen of a cankered branch which I had under observation in a culture chamber after some months produced these "perithecia." Without these it is not possible to certainly identify the fungus in the tissues of the tea plant as a *Nectria*. The assumption that all of the injuries as described on tea branches are due to this fungus is, I think, a fair one. The mycelium found in the tissues agrees with that in other parts of the plant where the fungus fruits; the pathological effect produced on the tea is similar to the injuries caused by other members of the family *Nectria*.

Should any of the cases of such wounds on tea be due to another fungus, the treatment would be exactly the same, so that from a practical planter's point of view the specific name of the fungus is not of much value. If, as is often asked, the wounds are due to accidental injuries and to rotting caused by organisms which are saprophytic, *i.e.*, only live in the dead portions of the tea plant, then wounds will soon be healed over by the plant without help. As observation and experience show that in the vast majority of cases this does not happen, it follows that these wounds must be kept open by the inroads of a parasitic organism. This must be removed before the plant can be expected to heal over the wounds.

So far my observations of the disease during last year have led me to the opinion that the spores of this branch canker of tea must have for some reason been present in abundance in Ceylon some five or six years ago, and that many bushes were affected then. My reasons for thinking that this is the case in this disease are that the largest number of cases of the canker show that it has been in the bush for some years, and cases of new infection are rarely met with. Continuous observations of this interesting disease, now that preventive measures are being adopted, will no doubt solve this problem, which is of great interest in dealing with the whole question of the origin and spread of parasitic diseases in economic plants.

Losses caused by Canker.

The amount of damage that this canker has done even on estates badly affected is not easy to estimate. I am inclined to think that a good deal of the reduction of crop on many fields which was in some cases put down to the soil becoming exhausted or to "bad seasons" has been due to the reduction of the leaf-producing area by the presence of this canker fungus.

In the case of a field which had, though heavily manured, gone back in crop from 850 to 500 lb. per acre in its yield, an examination after pruning showed that 80 per cent. of the bushes were badly attacked, and on these bushes some 20–30 per cent. of the leaf-bearing area of the branches was destroyed. This in itself may explain a reduction of 20 per cent. on the total leaf production of the field, and it was thus evident that the reduction in crop was mainly, if not entirely, due to the presence of the canker fungus, and could not be laid at the door of the manure being badly chosen or the season being unfavourable.

All fields should be thoroughly examined at pruning, so as to be assured that the bushes are not suffering from this disease, and consequently not in a condition to give so large a flush as if their branches were all healthy.

It must be remembered that this disease is local on the bush and does not affect the health of the plant except at the place attacked. A bush therefore may look as vigorous and healthy, and even more so than its neighbours, and yet it may be found when the branches are exposed at pruning time that a number of cankered areas exist on them.

There is no absolute proof that the tea bush can, unaided, ever get rid of the attack of the canker fungus. I have seen cases which gave the impression that direct sunlight had so discouraged the growth of the fungus that the wound was entirely healed over. I have also seen cases in which the attacks of white-ants seem to have cleared out the dead and

discoloured parts and enabled the tea bush to cover over the injured parts. In such cases of recovery it is not possible to definitely say that the origin of the wound was the canker fungus, and it is a much safer policy to consider that without aid from the planter the tea bush is unable to drive out this invader of its tissues.

Value of Curative Work.

The question of greatest importance in dealing with a disease attacking an economic product after discovering the nature of the disease is, Can this disease be effectually dealt with and without prohibitive cost eradicated? In the case of canker in tea the answer can certainly, I think, be given in the affirmative. No practical planter will expect that this or any other disease can be eradicated without cost. The amount which can from a business point of view be spent on freeing an estate from such a blight must be considered in the light of the damage done, *i.e.*, the loss in crop and the probable damage which may be done in the future if no means are taken to combat the evil. As was pointed out before in a bad case of branch canker, the reduction in crop may be estimated at about 20 per cent., and if the disease is not checked this percentage will naturally increase. To this percentage of loss must also be added a small proportion of the bushes totally killed by the fungus.

I had planned, had I stayed in the Island, some experiments to show how much a portion of a field would benefit by getting rid of the canker while the other half was untreated. If the amount of crop from each half was recorded, the result would give a practical proof of the value of the eradication of the canker. The beneficial results, however, could not be expected till some time, say two years or more, after the treatment, as until the wounds have entirely healed over no buds, *i.e.*, new wood, will be produced. If part of a field is treated and the other part left, an examination at the next pruning will give the best proof of the

benefit to the bushes by a comparison between the area of wounds on the branches of the bushes treated and those in which the canker has been allowed to spread unhindered.

In a cultivation carried on like that of tea in Ceylon, where the relative cost of all work is known, it is specially necessary to be able to point to a profit accruing from any money spent in curative and preventive treatment, and I have no doubt that if all the factors of the case in any field attacked by branch canker are taken into consideration the gain in crop when the fungus is eradicated will be found to be a very large one, and able to compensate for a relatively large outlay in preventive and curative work.

Curative Methods.

For the cure of all canker and other fungal diseases in the permanent parts of trees there is no treatment of any value but the surgical one. The knife is the best weapon. Any applications to the surface affect the surface only. Spraying with fungicides is of value in preventing new attacks of the fungus, but cannot act as a deterrent to the progress of the fungus when it has obtained a footing in the bark of the bush. All the discoloured parts should be cut out with a pruning or other knife. The large hook-shaped pruning knife is an excellent tool for this purpose if an edge is ground on the end of the knife above the hook; it thus becomes both a knife and a sort of chisel. For clearing out the dead tissue in the centre of branches where the wound is not very wide a half-gouge chisel, with the haft bent like a mason's trowel so as to enable it to be more easily inserted into the wound, is a useful tool. The wood can be gouged with this without running too far and injuring unnecessarily the healthy bark.

The wound should be left as clean as possible and with no roughness or places where water can easily lodge and thus encourage a new attack of the fungus.

The tea plant has an extraordinary recuperative power, and if the mycelium of the fungus, which keeps the wound open, is removed the bush will rapidly cover over the excised part. Under favourable conditions in eighteen months or two years, often before next pruning, the wound will be entirely healed and not be easily noticed without careful examination.

Cost of Treatment.

The cost per acre of the excision will naturally vary entirely with the number of bushes attacked, but it should not be higher than six or seven rupees on places where practically all the bushes are badly attacked.

A planter who has given me valuable help in this investigation, and who is carrying out the excision thoroughly, tells me that on fields where 20 to 25 per cent. of the bushes are attacked it took 8 to 10 coolies per acre at a cost of from Rs. 2·80 to Rs. 3·50, and he adds: "This is a very small expenditure if by our work we save the field from a serious loss of bushes."

The time during which the excision can be carried out is very limited. It should only be done directly after pruning, and it is best if the excision coolies follow directly after the pruners. If delayed after the buds are beginning to form, these buds are broken and damaged by the cooly in his handling the bush to cut out the canker.

The effect of direct sunlight is the greatest help possible to this eradication work. Sunlight is an excellent fungicide, and where a branch has been treated for canker and the diseased parts cut out and direct sunlight plays on the bush the cure is almost certainly complete. If, on the other hand, the excision is followed by a dense mist or constant rain keeping the branch wet and sodden, any small particle of the fungus which may have been left in the branch is enabled to go on growing and to spread further into the branch.

It is, of course, impossible that all pruning can be carried on in sunny weather, and it must naturally be arranged

according to conditions of labour and so as to prune all the estate at regular intervals. It is however worth serious consideration if it can be arranged that any fields badly attacked by the branch canker should either be pruned earlier or let run a little longer in order that the excision work can be carried on in dry weather, during which the curative measures are incomparably more effective.

Summary.

To sum up, the branch canker exists over a large area of tea in the Island, more especially at the higher elevations and on some of the finest tea, and this disease, though slow in its progress, if unchecked causes the death of the bush. It is probably responsible for a reduction of yield ascribed to other reasons. It is a disease which it is impossible to notice until the bushes are pruned. It is capable of treatment by surgical methods.

The excision of the cankered parts should be done immediately after pruning in order not to damage the young shoots, with a sharp knife or gouge. This treatment should cost from Re. 1 to Rs. 7 per acre, according to the number of bushes attacked. This expense can be more than justified, as the damage done by the fungus probably causes a reduction of crop up to 20 per cent. or more if not checked.

In conclusion, I would make a request that this disease should be carefully watched and its spread or decrease noticed. It is an evil which, as before explained, is specially apt to pass unobserved, and is therefore more insidious than leaf blights or some insect attacks the ravages of which are at once self-evident.

General Sanitary Measures.

The tea bush suffers from certain diseases, and like the tending of stock its diseases should be recognized and their treatment included in the routine of cultivation. I have

for some time advocated the system of having a small "sanitary" force of picked coolies, say one man to every 100 acres, continually going round examining the bushes for blights and diseases and treating them in the earliest stages of insect and fungal attacks. If an attack is serious and more than the cooly can himself overtake he should be told to inform the Superintendent, and a gang sufficient to cope with the evil detailed next day for the work. It is perhaps more true of the diseases of cultivated plants than of most things that a "stitch in time saves nine," except that it would be more correct to say "ninety-nine." An instance occurred some little time ago of an insect attack in the low-country, where owing to the caterpillars being allowed to thrive unchecked the district at last had to provide coolies for the Superintendent to rid his place of the evil, his own force being insufficient. If this help had not been given all the surrounding estates would have suffered serious loss, and if the disease had been checked at once it could probably have been done for a hundredth part of the cost. A preventive sanitary force, costing about Re. 1 an acre and considered as a fixed charge on the estate, just as are roads, weeding, or other necessary works, would I consider amply repay its cost in increased freedom from disease and consequently decreased losses in crop owing to injured or dead bushes.

The planter cannot himself visit the whole of his estate frequently enough to detect the earliest outbreaks of disease, and has not the time for the close examination which a cooly—who has been specially selected for the work—can make of the bushes if he has no other work to do but look after 100 acres.

I look forward to the day when on a 600-acre estate a special kangani who will become an expert at his work (and no one is more quick at detecting disease in the plants under his charge than the Tamil when he has once learnt to look out for it) will preside over a force of six or more coolies,

and by these means the estate will be kept free from many of the diseases which at present cause serious loss of profit to the tea industry.

I have to thank my friend Mr. Harold H. Mann, M.Sc., &c., Scientific Officer of the Indian Tea Association, for kindly allowing me to use the photographs here reproduced. They appear in the last edition of "Pests and Blights of the Tea Plant," by Sir George Watt and himself. The photograph of the disease in the older parts of the tea bush does not show the wide wounds with cushions of callus on each side as is typical of the disease on branches in Ceylon. As however I had no time to get any Ceylon specimens reproduced for printing I am glad to have these excellent pictures from India.

The first illustration shows the canker fungus on the young twigs, and the second on old stems; both are photographs taken by Mr. H. H. Mann himself.

I wish to thank many planters who by observations, notes, and help in the field have assisted me greatly in getting information about this disease. The mention of their names unfortunately is not a compliment, as I have found that this at once leads to the supposition that these gentlemen's estates are the most affected.

J. B. CARRUTHERS,
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November 10, 1904.

CANKER FUNGUS ON YOUNG TWIGS.

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CANKER FUNGUS ON OLD STEMS.

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